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APPARATUS AND METHOD FOR MANUFACTURING LIQUID CRYSTAL DISPLAY PANEL

[Abstract]

PROBLEM TO BE SOLVED: To provide an apparatus and a method for manufacturing a liquid crystal display panel capable of preventing the deterioration in quality of the liquid crystal display panel arising from a foreign material such as dust.

SOLUTION: In an apparatus and a method for manufacturing a liquid crystal display panel by uniting a first substrate 171 on which an adhesive 4 is applied and a liquid crystal material 3 is dropped and a second substrate 172, and then by uniting both substrates in a vacuum atmosphere, a dust preventing apparatus 130 is provided for preventing the deterioration in

quality of the liquid crystal display panel by a foreign materials such as dust existing in a vacuum vessel. Owing to the dust preventing apparatus, the accuracy in the gap distance between both substrates is not aggravated, and the positioning accuracy in the horizontal direction between both substrates is not aggravated. Thereby, the deterioration in quality of the liquid crystal display panel arising from dust can be prevented.

[Claims]

[Claim 1]

An apparatus for fabricating a liquid crystal display (LCD) panel with first and second substrates positioned to face each other in a vacuum container, comprising: a dust preventing unit for preventing degradation of quality of the LCD panel due to foreign material with respect to at least one of the first substrate maintaining unit for maintaining a first substrate and a second substrate maintaining unit for maintaining the second substrate.

[Claim 2]

The apparatus of claim 1, wherein the second substrate maintaining unit includes a second substrate support surface for horizontally maintaining the second substrate, and when the dust preventing unit is installed for the second substrate maintaining unit, having a second substrate support surface dust removing unit for removing foreign material from the second substrate support surface.

[Claim 3]

The apparatus of claim 2, wherein the second substrate support surface dust removing unit contacts with the second substrate support surface and includes a second substrate support surface dust removing member for removing foreign material of the second substrate support surface and a second substrate support surface dust removing member moving unit for moving the second substrate support surface dust removing member on the second substrate support surface.

[Claim 4]

The apparatus of claim 3, wherein the first substrate maintaining unit includes a first substrate support surface for horizontally maintaining the first substrate, and when the dust preventing unit is installed for the first substrate maintaining unit, the dust preventing unit includes a first substrate support surface dust removing unit for removing a foreign material of the first substrate support surface, and the first substrate support surface dust removing unit includes a first substrate support surface dust removing member contacting with the first substrate support surface and removing foreign material from the first substrate support surface and a first substrate support surface dust removing member moving unit for moving the first substrate support surface dust removing member on the first substrate support surface.

[Claim 5]

The apparatus of one of claims 1 to 4, wherein the first substrate maintaining unit is operable in a horizontal direction and a dust intrusion preventing unit for preventing intrusion of foreign material into a moving part is installed between the first substrate maintaining unit and the vacuum container.

[Claim 6]

The apparatus of claim 5, wherein the dust intrusion preventing unit includes a first dust intrusion preventing member whose one end is maintained in the vacuum container and the other end is maintained at the

first substrate maintaining unit, and freely moves the first substrate maintaining unit in the horizontal direction.

[Claim 7]

The apparatus of claim 5, wherein the dust intrusion preventing unit includes a second dust intrusion preventing member which is installed vertically on a bottom portion in the vacuum container to face the first substrate maintaining unit and surrounds the moving part of the first substrate maintaining unit.

[Claim 8]

The apparatus of claim 7, wherein a portion of the first substrate maintaining unit facing the second dust intrusion preventing member has a recess, and the second dust intrusion preventing member enters the recess in a non-contact state.

[Claim 9]

The apparatus of claim 5, wherein the dust intrusion preventing unit includes a suction hole opened on the bottom portion of the vacuum container near the region surrounding the moving part of the first substrate maintaining unit and a dust suction unit connected with the suction hole and sucking foreign material.

[Claim 10]

A method for fabricating a liquid crystal display (LCD) panel with first and second substrate positioned to face each other in a vacuum state,

comprising: removing dust to prevent degradation of quality of the LCD panel due to foreign material with respect to at least one side of a first substrate maintaining unit for maintaining the first substrate and a second substrate maintaining unit for maintaining the second substrate; and bonding the first and second substrates.

[Claim 11]

The method of claim 10, wherein, in the dust removing step, a dust removing member is moved on a first substrate of the first substrate maintaining unit and on a second substrate support surface of the second substrate maintaining unit.

[Title of the Invention]

APPARATUS AND METHOD FOR MANUFACTURING LIQUID CRYSTAL DISPLAY PANEL

[Detailed description of the Invention]

[Field of the Invention]

The present invention relates to an apparatus and method for fabricating a liquid crystal display (LCD) panel used as an image display panel of, for example, a personal computer, a TV set, or the like.

A related art apparatus for fabricating an LCD panel will now be described with reference to Figures 13 to 20.

As shown in Figure 13, an LCD panel 20 has such a structure that a lower substrate 1 and an upper substrate 2, which are made of a light-transmissive material such as glass, are positioned to face each other at a certain interval therebetween and a liquid crystal material 3 is charged in a space formed according to the interval. The upper and lower substrates 1 and 2 are bonded by an ultraviolet-hardening adhesive 4. The adhesive 4 includes spacers 5 each with a diameter of 5μm in order to maintain a certain interval between the lower and upper substrates 1 and 2. One method of placing the liquid crystal material 3 at an inner side of the adhesive 4 is a liquid crystal dropping method as shown in Figures 14 to 20.

First, in a first process as shown in Figure 14, the adhesive 4 is coated with a thickness of 30μm at edge boundaries of the lower substrate 1 made of the light-transmissive material.

Next, in a second process as shown in Figure 15, the liquid crystal

material 3 is dropped on certain regions of the lower substrate 1 surrounded by the adhesive 4.

In a third process as shown in Figure 16, on a table 7 installed in a chamber 11 and movable in a horizontal direction perpendicular in a thickness direction of the lower substrate 1 and the upper substrate 2 (to be described), and having an absorption mechanism 8, the lower substrate 1 is placed and then tightly fixed thereon according to a vacuum absorption operation by the absorption mechanism 8.

And then, in a fourth process as shown in Figure 17, the following operations are performed. Namely, a pressing mechanism 10 is moved in the chamber 11 along the thickness direction, and a moving plate 12 having an absorption mechanism 9 is installed to tightly fix an entire outer surface 2a of the upper substrate 2 onto the moving plate 12 by the absorption mechanism 9. And then, the chamber 11 is closed with a cover 13 and a vacuum is formed in the interior of the chamber 11. In the chamber 11 in the vacuum state, the moving plate 12 maintaining the upper substrate 2 is moved by operating the pressing mechanism 10 in the thickness direction to make the liquid crystal material 3 and the adhesive 4 contact with the upper substrate 2.

Thereafter, in a fifth process as shown in Figure 18, the table 7 maintaining the lower substrate 1 thereon is moved in the horizontal direction and the lower substrate 1 and the upper substrate 2 are position-aligned such that each pixel part of the corresponding liquid crystal display panel corresponds and a liquid crystal material driving unit of each pixel does not deviate in each position.

Subsequently, in a sixth process as shown in Figure 19, the moving plate 12 is lowered down toward the lower substrate 1 along the thickness direction by operating the pressing mechanism 10, the upper substrate 2 and the lower substrate 1 are attached by using the adhesive 4 and then pressed until a distance of a gap between the upper substrate 2 and the lower substrate 1 becomes 5 μm. And then, as mentioned above, the integrated lower and upper substrates 1 and 2 are taken out of the chamber 11.

In a seventh process as shown in Figure 20, the adhesive 4 is hardened by irradiating ultraviolet rays from a ultraviolet lamp 6 to thereby bond the integrated lower and upper substrate 1 and 2. Through the processes, a sheet of liquid crystal display panel 20 is completed.

[Problems to be solved by the Invention]

In order to fabricate the LCD panel without a defective image or image non-uniformity, the distance of the gap between the upper and lower substrates 2 and 1 needs to be 5μm within a tolerance of ±0.3μm, for which flatness of the lower substrate support surface 7a of the table 7 contacting with the lower substrate 1 and flatness of the upper substrate support surface 12a of the moving plate 12 contacting with the upper substrate 2 must be 1μm or below. Thus, if there is dust or a scrap of glass on the lower substrate support surface 7a or on the upper substrate support surface 12a, a dimension precision of the gap between the upper substrate 2 and the lower substrate 1 deteriorates to cause image deficiency or an image blot to degrade quality of the LCD panel.

In addition, in the related art apparatus for fabricating the LCD panel, in order to reduce time taken for forming a vacuum in the interior of the chamber 11, the size of the chamber 11 needs to be small. Thus, a mechanism for moving the table 7 in the horizontal direction has, for example, steel balls 15 between the table 7 and the bottom surface of the chamber 11 as shown in Figure 18. In this case, however, if a foreign material or a scrap of glass contacts with the steel balls 15, the table 7 cannot be smoothly moved in the horizontal direction and precision of position-alignment of the upper and lower substrates 2 and 1 deteriorates. Then, elements of each pixel and the liquid crystal material driving part of each pixel are deviated in their position, causing a defective image and an image blot to degrade quality of the LCD panel.

Therefore, an object of the present invention is to provide an apparatus and method for fabricating an LCD panel capable of preventing degradation of quality of the LCD panel resulted from a foreign material such as dust.

[Means for solving the problem]

To achieve the above object, there is provided an apparatus for fabricating a liquid crystal display (LCD) panel with first and second substrates positioned to face each other in a vacuum container, comprising: a dust preventing unit for preventing degradation of quality of the LCD panel due to a foreign material with respect to at least one of the first substrate maintaining unit for maintaining a first substrate and a second substrate maintaining unit for maintaining the second substrate.

The second substrate maintaining unit includes a second substrate support surface for horizontally maintaining the second substrate, and when the dust preventing unit is installed for the second substrate maintaining unit, it can have a second substrate support surface dust removing unit for removing the foreign material from the second substrate support surface.

The second substrate support surface dust removing unit contacts with the second substrate support surface and includes a second substrate support surface dust removing member for removing the foreign material of the second substrate support surface and a second substrate support surface dust removing member moving unit for moving the second substrate support surface dust removing member on the second substrate support surface.

The first substrate maintaining unit includes a first substrate support surface for horizontally maintaining the first substrate, and when the dust preventing unit is installed for the first substrate maintaining unit, the dust preventing unit includes a first substrate support surface dust removing unit for removing a foreign material of the first substrate support surface, and the first substrate support surface dust removing unit includes a first substrate support surface dust removing member contacting with the first substrate support surface and removing a foreign material from the first substrate support surface and a first substrate support surface dust removing member moving unit for moving the first substrate support surface dust removing member on the first substrate support surface.

The first substrate maintaining unit is moved in a horizontal direction and a dust intrusion preventing unit for preventing intrusion of a foreign

material into a moving part is installed between the first substrate maintaining unit and the vacuum container.

The dust intrusion preventing unit includes a first dust intrusion preventing member whose one end is maintained in the vacuum container and the other end is maintained at the first substrate maintaining unit, and freely moves the first substrate maintaining unit in the horizontal direction.

The dust intrusion preventing unit includes a second dust intrusion preventing member which is installed vertically on a bottom portion in the vacuum container to face the first substrate maintaining unit and surrounds the moving part of the first substrate maintaining unit.

The first substrate maintaining unit facing the second dust intrusion preventing member has a recess, and the second dust intrusion preventing member enters the recess in a non-contact state.

The dust intrusion preventing unit includes a suction hole opened on the bottom portion of the vacuum container near the region surrounding the moving part of the first substrate maintaining unit and a dust suction unit connected with the suction hole and sucking a foreign material.

To achieve the above object, there is also provided a method for fabricating a liquid crystal display (LCD) panel with first and second substrate positioned to face each other in a vacuum state, comprising: removing dust to prevent degradation of quality of the LCD panel due to a foreign material with respect to at least one side of a first substrate maintaining unit for maintaining the first substrate and a second substrate maintaining unit for maintaining the second substrate; and bonding the first and second substrates.

[Embodiment of the invention]

An apparatus for fabricating an LCD panel and a method for fabricating the LCD panel executed in the LCD panel fabricating apparatus in accordance with a preferred embodiment of the present invention will now be described with reference to the accompanying drawings.

The same elements are given the same reference numerals. In this embodiment, the LCD panel fabricated in the LCD panel fabricating apparatus has a size of 4~23 inches and includes a mother glass type that each LCD panel can be separately divided from a mother glass and a type that one LCD panel is formed with a pair of substrates.

A basic structure of the LCD panel fabricating apparatus in this embodiment of the present invention is similar to the related art LCD panel fabricating apparatus as shown in Figure 17, but the LCD panel fabricating apparatus in accordance with the present invention includes a dust preventing unit as a characteristic element. Namely, a first substrate maintaining unit for maintaining a first substrate for constituting an LCD panel is provided and a second substrate maintaining unit for maintaining a second substrate for constituting the LCD panel is positioned at an upper side of the first substrate maintaining unit in a vacuum container for fabricating an LCD panel. The dust preventing unit prevents a foreign material such as dust existing in the vacuum container from working against at least one of the first and second substrate maintaining units and thus prevent degradation of quality of the LCD panel due to the foreign material. The dust preventing unit includes a gap precision maintaining type directed

to prevent the foreign material such as dust from working against to thereby obtain numerical precision of the gap between the first and second substrates and quality LCD panel, and a disposition precision maintaining type directed to prevent the foreign material working against a moving part of the first substrate maintaining unit to thereby obtain a position alignment precision between the first and second substrates and obtain quality LCD panel.

An example of the gap precision maintaining type is a second gap precision maintaining unit 190 as shown in Figure 9 and a first gap precision maintaining unit 193 as shown in Figure 10. An example of the disposition prevision maintaining type is a first disposition precision maintaining unit 190, a second disposition precision maintaining unit 140 and a third disposition precision maintaining unit 150 as shown in Figures 1 to 3.

The foreign material such as dust refers to remnants of glass, namely, a material of the first and second substrates 171 and 172, a foreign material intruded into or generated in the vacuum container 123, or the like, which works to degrade a distance 173 between the first and second substrates 171 and 172 or degrade precision in determining a position of the first substrate 171 with the second substrate 172 in the horizontal direction. The disposition precision maintaining units 130, 140 and 150 correspond to the dust intrusion preventing unit.

Among various dust preventing units to be described in turn, first, an LCD panel fabricating apparatus 101 having the dust preventing unit in accordance with the present invention will now be described.

As shown in Figure 1, the LCD panel fabrication apparatus 101

includes first and second substrate maintaining units 124 and 125 in a vacuum container 123 and the dust preventing unit. A vacuumization unit 122 is connected with the vacuum container 123. After the vacuum container 123 is closed by a cover 1231, the interior of the vacuum container 123 is vacuumized through sucking by the vacuumization unit 122.

The first substrate maintaining unit 124 is made of a light-transmissive material such as, for example, glass or plastic, maintains a first substrate 171 constituting a corresponding LCD panel 174 thereon in the vacuum container 123 through an absorption operation, and includes a first base plate 1241, a first base plate driving unit 1242 and a first base plate suction unit 1243. A moving part 1246 is installed between a bottom portion 1232 of the vacuum container 123 and the first base plate 1241 and moves the first base plate 1241 in a horizontal direction 1245. In this embodiment, the moving part 1246 arranges steel balls 15 so as to be freely rotated, for example, in a grid form, which support a bottom facing surface 1257 of the first base plate 1241. The first base plate 1241 includes a first substrate support surface 1241a for mounting the first substrate 171 thereon and supporting the entire outer surface 1711 of the first substrate 171. The horizontal direction 1245 is perpendicular to a thickness direction of the first substrate 171 mounted on the first base plate 1241. The first base plate 1241 having the moving part 1246 is moved in the horizontal direction 1245 on the bottom portion 1232 of the vacuum container 123 by a first base plate driving unit 1242 controlled by a control unit 180 provided in the LCD panel fabricating apparatus 101. The first base plate suction unit 1243 controlled by the control unit 180 is connected with the first base plate 1241. The first

base plate suction unit 1243 performs sucking through a plurality of suction hole 1244 holed on the support 1241a corresponding to the outer surface 1711 of the first substrate 171. Through the sucking operation, the first substrate 171 mounted on the first base plate 1241 is adsorbed onto the support surface 1241a of the first base plate 1241.

The second substrate maintaining unit 125 is made of a light transmissive material such as, for example, glass or plastic, maintains a second substrate 172 constituting a corresponding LCD panel 174 thereon in the vacuum container 123 through an absorption operation, and moves the second substrate 172 toward the first substrate 171 to set a distance of a gap between the first and second substrates 171 and 172 according to a designed value. The second substrate maintaining unit 125 includes a second base plate 1251, a second base plate driving unit 1252 and a second base plate suction unit 1253. The second base plate 1251 can be excluded with respect to the vacuum container 123. As shown in Figure 1, when the second base plate 1251 is mounted in the vacuum container 123, it is positioned to face the first base plate 1241, guided on a wall surface 1233 of the vacuum container 123, and freely moved in a thickness direction of the second substrate 172 by the second base plate driving unit 1252 controlled by the control unit 180. The second base plate 1251 includes a support surface 1251a supporting the entire outer surface 1721 of the second substrate 172, and the second base plate suction unit 1253 controlled by the control unit 180 is connected with the second base plate 1251 and performs sucking through a plurality of suction holes 1254 formed on the support surface 1251a corresponding to the outer surface 1721 of the second

substrate 172. Accordingly, the second substrate 172 is adsorbed onto the support surface 1251a of the second base plate 1251.

In a state that the second substrate 172 is adsorbed on the second base plate 1251, the second base plate driving unit 1252 moves the second base plate 1251 toward the first substrate 171 to make the second substrate 172 approach the first substrate 171 adsorbed on the first base plate 1241, and in this case, the distance 173 of the gap between the first and second substrates 171 and 172 is 5μm in this embodiment. Also, in this embodiment, the second base plate driving unit 1252 is installed on the second base plate 1251 and moves the second substrate 172 toward the first substrate 171, but the present invention is not limited thereto. Namely, the first substrate 171 can be moved toward the second substrate 172, or both the first and second substrates 171 and 172 can be moved together. But preferably, the first and second substrates 171 and 172 are relatively moved in the thickness direction of the substrates.

The first disposition precision maintaining unit 130 provided in the LCD panel fabricating apparatus 101 in accordance with the present invention will now be described.

The first disposition precision maintaining unit 130 is formed as a first dust intrusion preventing member 131 whose one end 1311 is maintained by a wall surface 1233 in every direction of the wall surface 1233 of the vacuum container 123 corresponding to a side portion of the vacuum container 123 and the other end 1312 is maintained by every direction of the first base plate 1241. As mentioned above, the first base plate 1241 is moved in the horizontal direction 1245 by the first base plate driving unit 1242, the

first dust intrusion preventing member 131 is made of a material and has a thickness which does not interfere movement of the first base plate 1241 in the horizontal direction 1245, and is mounted to be loose so as not to interfere movement of the first base plate 1241. Preferably, the first dust intrusion preventing member 131 is formed of a flexible sheet such as a resin material or a paper material.

The first dust intrusion preventing member 131 prevents intrusion of a foreign material such as dust into the moving part 1246 from the first base plate 1241 or from the second base plate 1251 disposed above the first base plate 1241. Thus, the other end 1312 of the first dust intrusion preventing member 131 is provided at a position where it cannot interfere mounting of the first substrate 171 on the first base plate 1241 and movement of the moving part 1246 and the first substrate 171. For example, preferably, the other end 1312 can be provided at a side 1241b of the first base plate 1241 facing the wall surface 1233 of the vacuum container 123. The end 1311 of the first dust intrusion preventing member 131 is tightly attached to the wall surface 1233 with no gap therebetween and the other end 1312 is tightly attached to the first base plate 1241 with a gap therebewteen so that a foreign material between the wall surface 1233 of the vacuum container 123 and the first base plate 1241 cannot intrude toward the moving part 1246.

By installing the first dust intrusion preventing member 131, the interior of the vacuum container 123 is divided into an upper region 1234 and a lower region 1235. Thus, to perform sucking on both upper and lower regions 1234 and 1235, a suction opening 1221 communicating with the vacuumization unit 122 is formed at both upper and lower regions 1234 and

1235 so that the interior of the vacuum container 123 can be entirely vacuumized. In this case, as a matter of course, a foreign material cannot intrude from the upper region 1234 to the lower region 1235 through a suction passage communicating with the suction opening 1221 opened with the upper and lower regions 1234 and 1235.

By installing the first dust intrusion preventing member 131, a foreign material in the upper region 1234 is maintained on the first dust intrusion preventing member 131 and cannot intrude into the lower region 1235 and further into the moving part 1246. Thus, since movement of the moving part 1246 is not interfered by the foreign material and thus the first base plate 1241 can be smoothly moved in the horizontal direction 1245. Accordingly, when the first base plate 1241 is moved in the horizontal direction 1245 and the first and second substrates 171 and 172 are position-aligned such that each pixel of the corresponding LCD panel can correspond to each other and the liquid crystal material driving unit of each pixel can be disposed without deviation, degradation of position determining precision between the first and second substrates 171 and 172 can be prevented. Thus, generation of a defective image or image non-uniformity resulted from the foreign material can be prevented, and thus, degradation of quality of the LCD panel can be prevented.

A second disposition precision maintaining unit 140 provided in an LCD panel fabricating apparatus 102 will now be described with reference to Figure 2. The LCD panel fabricating apparatus 102 is different from the LCD panel fabricating apparatus 101 only in that the former has the second disposition precision maintaining unit 140 in place of the first disposition

precision maintaining unit 130. Other constructions are the same. Thus, description of a basic construction of the LCD panel fabricating apparatus 102 will be omitted, and only the second disposition precision maintaining unit 140 will be described as follows.

In this embodiment, as shown in Figure 4, the second disposition precision maintaining unit 140 includes a second dust intrusion preventing member 141 and a recess 142 which enters in a non-contact state of the second dust intrusion preventing member 141 to interfere intrusion of a foreign material such as dust into the moving part 1246. The second dust intrusion preventing member 141 is installed on a bottom portion 1232 of the vacuum container 123 to face a support surface 1241a of the first base plate 1241 of the first substrate 171 and face the first base plate 1241 over every direction of the bottom portion facing surface 1247 facing the bottom portion 1232 of the vacuum container 123. With such installation of the second dust intrusion preventing member 141, the moving part 1246 is surrounded by the second dust intrusion preventing member 141. The recess 142 of the bottom portion facing surface 1247 of the first base plate 1241 corresponds to the second dust intrusion preventing member 141, and is formed in the every direction of the bottom portion facing surface 1247 as shown in Figure 5. A depth 1421 of the recess 142 is about 5mm and a width 1422 of the recess is about 10mm. A gap 1423 between the second dust intrusion preventing member 141 and the recess 142 has such a distance as not to interfere movement in the horizontal direction 1245 in the first base plate 1241 and intrusion of the foreign material into the moving part 1246.

With the second dust intrusion preventing member 141 and the

recess 142 installed, the foreign material wants to intrude into the moving part 1246, it must pass through the gap 1423 between the second dust intrusion preventing member 141 and the recess 142. Thus, intrusion of the foreign material into the moving part 1246 is interfered compared a case where the second dust intrusion preventing member 141 and the recess 142 are not installed. Thus, interference of the movement of the moving part 1246 by the foreign material can be prevented and the first base plate 1241 can be smoothly moved in the horizontal direction 1245. Accordingly, when the first base plate 1241 is moved in the horizontal direction 1245 and the first and second substrates 171 and 172 are position-aligned such that each pixel of the corresponding LCD panel can correspond to each other and the liquid crystal material driving unit of each pixel can be disposed without deviation, degradation of position determining precision between the first and second substrates 171 and 172 can be prevented. Thus, generation of a defective image or image non-uniformity resulted from the foreign material can be prevented, and thus, degradation of quality of the LCD panel can be prevented.

In this embodiment, the second dust intrusion preventing member 141 and the recess 142 are formed as the second disposition precision maintaining unit 140, and in this case, the recess 142 is not necessarily formed. For example, as shown in Figure 6, a second dust intrusion preventing member 143 with a villi portion 1431 which contacts with the bottom portion facing surface 1247 of the first base plate 1241 to prevent intrusion of the foreign material such as dust into the moving part 1246 can be formed as the second disposition precision maintaining unit 140.

Likewise the second dust intrusion preventing member 141 as described above, the second dust intrusion preventing member 143 also faces over the entire circumferential surface of the bottom portion facing surface 1247 and surrounds the moving part 1246. The villi portion 1431 does not apply resistance as strong as to restrain movement of the first base plate 1241 in the horizontal direction 1245 to the first base plate 1241. Installation of the second dust intrusion preventing member 143 can have the same effect as the above-described second dust intrusion preventing member 141.

A third disposition precision maintaining unit 150 provided in an LCD panel fabricating apparatus 103 will now be described with reference to Figure 3. The LCD panel fabricating apparatus 103 is different from the LCD panel fabricating apparatuses 101 and 102 only in that the former has the third disposition precision maintaining unit 150 in place of the first and second disposition precision maintaining units 130 and 140. Other constructions are the same. Thus, description of a basic construction of the LCD panel fabricating apparatus 103 will be omitted, and only the third disposition precision maintaining unit 140 will be described as follows.

The third disposition precision maintaining unit 150 includes a suction hole 151 formed near the first base plate 1241 and at a lower portion of the vacuum container 123, namely, in this embodiment, on the bottom portion 1232, and a dust suction unit 152 for sucking a foreign material such as dust intruding into the moving part 1246 through the suction hole 151 under the control of the control unit 180. As shown in Figure 7, the suction hole 151 can have circular holes formed at certain intervals around the first base plate 1241 or can be a groove opening successively formed around the

first base plate 1241. Because the interior of the vacuum container 123 needs to be maintained in the vacuum state, a valve 153 is installed between the suction hole 151 and the dust suction unit 152 in order to switch off or switch on to cut off or communicate the interior of the vacuum container 123 and the dust suction unit 152.

The third disposition precision maintaining unit 150 performs suction by means of the dust suction unit 152 with the suction hole 151 and the valve 153 interposed therebetween when the interior of the vacuum container 123 is in a state of an atmospheric pressure. Through the sucking operation, the foreign material existing especially at the bottom portion 1232 of the vacuum container 123 is sucked to the dust suction unit 152. After the sucking operation during a certain time is terminated, the valve 153 is closed to set the interior of the vacuum container 123 into the vacuum state.

Thus, since the third dust intrusion preventing member 150 is installed to suck the foreign material existing at the bottom portion 1232, intrusion of the foreign material into the moving part 1246 can be prevented, Therefore, interference of the movement of the moving part 1246 by the foreign material can be prevented and the first base plate 1241 can be smoothly moved in the horizontal direction 1245. Accordingly, when the first base plate 1241 is moved in the horizontal direction 1245 and the first and second substrates 171 and 172 are position-aligned such that each pixel of the corresponding LCD panel can correspond to each other and the liquid crystal material driving unit of each pixel can be disposed without deviation, degradation of position determining precision between the first and second substrates 171 and 172 can be prevented. Thus, generation of a defective

image or image non-uniformity resulted from the foreign material can be prevented, and thus, degradation of quality of the LCD panel can be prevented.

The second gap precision maintaining unit 190 as an embodiment of the dust preventing unit of the gap precision maintaining type will now be described. The second gap precision maintaining unit 190 corresponds to the second substrate support surface dust removing unit. An LCD panel fabricating apparatus 104 as show in Figure 9 includes the second gap precision maintaining unit 190. The LCD panel fabricating apparatus 104 as shown in Figure 9 shows a simple structure, which, however, has the second gap precision maintaining unit 190 in place of the first disposition precision maintaining unit 130 provided in the above-described LCD panel fabricating apparatus 101. Namely, the LCD panel fabricating apparatus 104 has almost the same construction as the LCD panel fabricating apparatus 101, so description of the same construction as the LCD panel fabricating apparatus 101 will be omitted and only the second gap precision maintaining unit 190 will be described as follows. Though not shown in Figure 9, a second substrate maintaining unit 125 is supported upwardly of the first base plate 1241 by a certain member.

The second gap precision maintaining unit 190 is to maintain precision of a distance 173 between the first and second substrates 171 and 172 by removing a foreign material from the support surface 1251a of the second substrate 172 of the second base plate 1251. In detail, the second gap precision maintaining unit 190 includes a second base plate dust removing member 191 which contacts the support surface 1251a of the

second base plate 1251 and removes the foreign material such as dust existing on the support surface 1251a, and a second base plate moving unit 192 for moving the second base plate dust removing member 191 on the support surface 1251a. The second base plate dust removing member 191 is equivalent to a second substrate support surface dust removing member, and the second base plate moving unit 192 is equivalent to a second substrate support surface dust removing member moving unit.

The second base plate moving unit 192 includes a support member 1921 for supporting the second base plate dust removing member 191 so as for the second base plate dust removing member 191 to contact with the support surface 1251a and a driving mechanism 1922 for moving the support member 1921, namely, the second base plate dust removing member 191, in the longitudinal direction 1925 of the second base plate 1251. The driving mechanism 1922 includes a ball screw portion 19221 having the support member 1921, a driving source 19222 for driving the ball screw portion 19221 and controlled by the control unit 180, and a guide unit 19223 for guiding movement of the support member 1921.

The second base plate dust removing member 191 can be anything so long as it has the function of removing the foreign material such as dust from the support surface 1251a, and can have any form, and in this embodiment, as shown in Figure 11, the second base plate dust removing member 191 has a length exceeding the entire width of the support surface 1251 and is formed as a rollable bar member that can be rotatably moved on the support surface 1251a. As mentioned above, because the second base plate dust removing member 191 is moved in the longitudinal direction 1925

while contacting on the support surface 1251a, the foreign material such as dust existing on the support surface 1251a can be attached on the second base plate dust removing member 191, and thus, the support surface 1251a can be cleaned. In addition, since the second base plate dust removing member 191 has the roller shape, it can be smoothly moved on the support surface 1251a and thus operability of removing the foreign material such as dust from the support surface 1251a can be enhanced.

In addition, the second base plate dust removing member 191 can be made of a rubber material to enhance the property of removing the foreign material. Moreover, the second base plate dust removing member 191 can be made of an elastic material such as rubber and have a surface with viscosity to more enhance the power of removing the foreign material such as dust. In addition, an elastic support member, such as spring, for pressing the second base plate dust removing member 191 onto the support surface 1251a can be provided at the support member 1921 in order to better contact of the second base plate dust removing member 191 with the support surface 1251a. By doing that, the power of removing of the foreign material such as dust can be more enhanced.

In this manner, by installing the second base plate dust removing member 191 and the second base plate moving unit 192, the foreign material existing on the support surface 1251a of the second base plate 1251 can be removed, so that when the second substrate 172 is adsorbed to be maintained on the support surface 1251a, there is little foreign material between the support surface 1251a and the outer surface 1721 of the second substrate 172. Thus, such a phenomenon that the second substrate 172

maintained on the support surface 1251a has a convex portion on the first substrate 171 due to the foreign material such as dust existing between the support surface 1251a and the outer surface 1721 cannot happen, so degradation of precision of the distance 173 of the gap between the first and second substrates 171 and 172 can be prevented. Thus, generation of a defective image or image non-uniformity resulted from the foreign material can be prevented, and thus, degradation of quality of the LCD panel can be prevented.

In addition, as shown in Figure 10, the first gap precision maintaining unit 193 for removing a foreign material existing on the support surface 1241a of the first base plate 1241 as well as on the support surface 1251a of the second base plate 1251 can be additionally installed. The first gap precision maintaining unit 193 as shown in Figure 10 has the same elements as those of the second gap precision maintaining unit 190. The same reference numerals are given to the same elements and description for them will be omitted. The first gap precision maintaining unit 193 is equivalent to a first substrate support surface dust removing unit, the second base dust removing member 191 is equivalent to a first substrate support surface dust removing member, and the second base plate moving unit 192 is equivalent to a first substrate support surface dust removing member moving unit.

In this manner, by installing the first gap precision maintaining unit 193 in addition to the second gap precision maintaining unit 190, no foreign material can be come between the support surface 1241a of the first base plate 1241 and the outer surface 1711 of the first substrate 171, and thus, such a phenomenon that the first substrate 171 maintained on the support

surface 1241a has a convex portion on the second substrate 172 due to the foreign material cannot happen. Accordingly, degradation of precision of the distance 173 of the gap between the first and second substrates 171 and 172 can be prevented, and thus, generation of a defective image or image non-uniformity resulted from the foreign material can be prevented and degradation of quality of the LCD panel can be prevented.

When both the second and first gap precision maintaining units 190 and 193 are installed, the foreign material such as dust drops due to gravity. Thus, it is preferred that the support surface 1251a of the second base plate 1251 in the second gap precision maintaining unit 190 is first cleaned, and then, the support surface 1241a of the first base plate 1241 in the first gap precision maintaining unit 193 is cleaned.

In addition, one of the first disposition precision maintaining unit 130, the second disposition precision maintaining unit 140 and the third disposition precision maintaining unit 150 is installed, and at least the second gap precision maintaining unit 190 among the second gap precision maintaining unit 190 and the first gap precision maintaining unit 193.

A method for fabricating the LCD panel by using the LCD panel fabricating apparatus having the first disposition precision maintaining unit 130 and the second gap precision maintaining unit 190. The LCD panel fabricating method is performed under the control of the control unit 180.

Before starting fabrication of the LCD panel, as shown in figure 9, the support surface 1251a is first cleaned by using the second gap precision maintaining unit 190. If the first gap precision maintaining unit 193 is also installed, the support surface 1241a of the first base plate 1241 is also

cleaned by using the first gap precision maintaining unit 193 as shown in Figur3e 10, after the support surface 1251a is cleaned.

Next, the first substrate 171 with the liquid crystal material 3 and the ultraviolet-hardening adhesive 4 coated with a thickness of 30μm thereon is mounted on the support surface 1241a of the first base plate 1241. And then, the entire outer surface 1711 of the first substrate 171 is adsorbed onto the first base plate 1241 by operating the first base plate suction unit 1243 in an atmospheric pressure, to fix the first substrate 171 to the first base plate 1241.

And then, the entire outer surface 1721 of the second substrate 172 is adsorbed on the support surface 1251a of the second base plate 1251 in the atmospheric pressure by operating the second base plate suction unit 1253 to fix the second substrate 172. The second base plate 1251 with the second substrate 172 fixed thereon is positioned such that the second substrate 172 face the first substrate 171, and mounted in the vacuum container 123. And then, the vacuum container 123 is closed with the cover 1231 and is vacuumized. The second base plate 1251, namely, the second substrate 172, is moved toward the first substrate 171 by operating the second base plate driving unit 1252 of the substrate maintaining unit 125 so that the inner surface 1722 of the second substrate 172 can come in contact with the adhesive 4 or the liquid crystal member 3 coated on the first substrate 171.

Thereafter, the first base plate driving unit 1242 of the first substrate maintaining unit 124 is operated such that the liquid crystal material driving unit of each pixel is disposed without being deviated corresponding to each

pixel of the corresponding LCD panel, and the first base plate 1241 maintaining the first substrate 171 thereon is moved in the horizontal direction 1245 perpendicular to the thickness direction of the first substrate 171 so as to be position-aligned with the second substrate 172.

After the position alignment, the second base plate driving unit 1252 is operated, and as shown in Figures 1 to 3, the second base plate 1251, namely, the second substrate 172, is moved toward the first substrate until the distance 173 of the gap between the first and second substrates 171 and 172 becomes 5μm.

Since the vacuum container 123 is in the vacuum state, the liquid crystal material 3 is positioned on the inner surface 1712 of the first substrate 171, and is closed without an air bubble at the inner side surrounded by the adhesive 4. 5μm is equal to the size of the spherical spacer 5 included in the adhesive 4, and the second substrate 172 is moved toward the first substrate 171 until its movement is restrained by the spacer 5.

After the vacuum state in the vacuum container 123 is released, the LCD panel consisting of the first and second substrates 171 and 172 attached with the distance 173 of 5μm therebetween is returned to an ultraviolet ray irradiation position outside the vacuum container 123. As shown in Figure 12, an ultraviolet ray for hardening the adhesive 4 is irradiated from an ultraviolet ray source 6 to the LCD panel 174. Then, the adhesive 4 is hardened and the first and second substrates 171 and 172 are bonded to complete formation of the LCD panel 174.

In the above described fabrication operation, in the case that the

third disposition precision maintaining unit 150 is installed in place of the first disposition precision maintaining unit 130, the following operation can be performed.

Namely, since the foreign material can drop, after the cleaning performed by using the second gap precision maintaining unit 190 and the first gap precision maintaining unit 193 is completed, when the interior of the vacuum container 123 is in the atmospheric pressure, the suction unit 153 is first operated to suck the foreign material existing at the bottom portion 12323 of the vacuum container 123. After the sucking operation is completed, a follow-up operation can be executed.

[Effect of the invention]

As so far described, the apparatus and method for fabricating the LCD panel in accordance with the present invention have many advantages.

That is, for example, since the dust preventing unit is provided, the foreign material such as dust in the vacuum container working against at least one of the first substrate maintaining unit for maintaining the first substrate and the second substrate maintaining unit for maintaining the second substrate can be prevented. Thus, degradation of the gap precision between the bonded first and second substrates due to the foreign material can be prevented and degradation of the position determining precision in the horizontal direction of the first and second substrates due to the foreign material can be prevented. As a result, degradation of quality of the LCD panel resulted form the foreign material can be prevented.

In addition, in case where the dust preventing unit is the second

substrate support surface dust removing unit installed for the second substrate maintaining unit, the second substrate support surface dust removing unit removes the foreign material such as dust from the second substrate support surface of the second base plate provided in the second substrate maintaining unit. Accordingly, when the second substrate is maintained at the second substrate maintaining unit, insertion of the foreign material such as dust between the second base plate and the second substrate can be prevented. Thus, a phenomenon that the second substrate maintained on the second substrate maintaining unit has a convex shape with the first substrate can be prevented, so when the first and second substrates are bonded, good gap precision therebetween can be maintained. Accordingly, degradation of quality of the LCD panel can be prevented.

Since the second substrate support surface dust removing unit includes the second substrate support surface dust removing member and the second substrate support surface dust removing member moving unit, the foreign material such dust existing on the second substrate support surface can be smoothly removed.

As the dust preventing unit, the first substrate support surface dust removing unit can be maintained on the first substrate maintaining unit, or the foreign material such as dust can be removed from the first substrate support surface of the first base plate provided on the first substrate maintaining unit. Thus, like the case of the second substrate support surface dust removing unit, degradation of quality of the LCD panel resulted from the foreign material can be prevented.

As the dust preventing unit, the dust intrusion preventing unit can be

provided for preventing intrusion of the foreign material such as dust into the moving part, namely, the actuating part provided at the first substrate maintaining unit. By using the dust intrusion preventing unit, intrusion of the foreign material such as dust into the moving part can be prevented, so that interference by the foreign material of the movement of the moving part in the horizontal direction can be prevented. Accordingly, the disposition precision in the horizontal direction of the first and second substrates can be maintained and degradation of quality of the LCD panel resulted from the foreign material can be prevented.

The dust intrusion preventing unit can include the first dust intrusion preventing member, the second dust intrusion preventing member, the suction hole and the dust suction unit. Since the first dust intrusion preventing member can hardly affect the horizontal movement of the first substrate, the disposition precision of the first substrate can be maintained. When the second dust intrusion preventing member is used, since it does never affect the horizontal movement of the first substrate, the disposition precision of the first substrate can be more enhanced. When the suction hole and the dust suction unit are used, the foreign material such dust can be discharged from the vacuum container, so that influence of the foreign material can be considerably reduced.

[Description of drawings]

Figure 1 illustrates a structure of an LCD panel having a first disposition precision maintaining unit in accordance with a preferred embodiment of the present invention;

Figure 2 illustrates a structure of an LCD panel having a second disposition precision maintaining unit in accordance with the preferred embodiment of the present invention;

Figure 3 illustrates a structure of an LCD panel having a third disposition precision maintaining unit in accordance with the preferred embodiment of the present invention;

Figure 4 is an enlarged view of the second disposition precision maintaining unit of Figure 2;

Figure 5 is a plan view of a first base plate for showing formation of a recess of Figure 4;

Figure 6 illustrates a modification of the second disposition precision maintaining unit of Figure 2;

Figure 7 is a plan view of a bottom portion of a vacuum container for showing formation of suction holes of the third disposition precision maintaining unit of Figure 3;

Figure 8 is a plan view of a bottom portion of a vacuum container for showing formation of suction holes of the third disposition precision maintaining unit of Figure 3;

Figure 9 illustrates a structure of an LCD panel having a gap precision maintaining unit in accordance with the preferred embodiment of the present invention;

Figure 10 illustrates a structure of an LCD panel having a gap precision maintaining unit in accordance with the preferred embodiment of the present invention;

Figure 11 is a plan view of the gap precision maintaining unit of

Figure 10;

Figure 12 illustrates hardening of an adhesive of the LCD panel fabricated in the LCD panel fabricating apparatus in accordance with the preferred embodiment of the present invention;

Figure 13 is a sectional view of a related art LCD panel;

Figure 14 shows a state that an adhesive is coated on a first substrate according to an operation for fabricating the related art LCD panel;

Figure 15 shows a state that a liquid crystal material is coated on the first substrate according to the operation for fabricating the related art LCD panel;

Figure 16 shows a state that the first substrate is disposed on a table according to the operation for fabricating the related art LCD panel;

Figure 17 shows a state that the first substrate and a second substrate are allowed to approach each other according to the operation for fabricating the related art LCD panel;

Figure 18 shows a state that the first substrate and the second substrate are position-aligned according to the operation for fabricating the related art LCD panel;

Figure 19 shows a state that the first substrate and the second substrate are pressed to have a certain value of a gap therebetween according to the operation for fabricating the related art LCD panel; and

Figure 20 shows a state that the adhesive is hardened according to the operation for fabricating the related art LCD panel.